EGG DEVELOPMENT OF *TREMATOMUS EULEPIDOTUS* REGAN, 1914 (NOTOTHENIIDAE, PISCES) FROM THE WEDDELL SEA, ANTARCTICA.

by

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ABSTRACT. - During the third cruise of the German RV *Polarstern* to the Weddell Sea in Jan./Feb. 1985, a sample of approximately 2000 fertilized eggs of *Trematomus eulepidotus* was collected with a bottom trawl. About half of these eggs were transferred to an aquarium and incubated over a period of 5 months. The development of the eggs took 131 to 159 days from stage I (gastrulation stage) to hatching at a mean temperature of about 0°C. Larval length at hatching was 18.6 mm standard length.

RÉSUMÉ. - Pendant la troisième campagne du navire océanographique allemand *Polarstern* en mer de Weddell, de Janvier à Février 1985, une ponte amalgamée d'environ 2000 oeufs fécondés de *Trematomus eulepidotus* a été recueillie par un chalut de fond. Environ la moitié de ces oeufs a été transférée dans un aquarium, et l'incubation a été suivie pendant une période de 5 mois. Le développement embryonnaire dure de 131 à 159 jours, du stade I (stade de gastrulation) jusqu'à l'éclosion, à la température moyenne de 0°C. La longueur standard des larves est alors de 18,6 mm.

Key-words : Nototheniidae, *Trematomus eulepidotus*, PSW, Weddell Sea, Embryonic development, Larvae.

Eggs of nototheniid fishes in the Southern Ocean are generally considered to be demersal but there are very few observations which have been reported (Moreno, 1980 ; Daniels, 1978, 1979 ; White *et al.*, 1982). This is the reason why information on egg stages and duration of egg development is very fragmentary. Such information, however, is essential to understand larval survival strategies. The first investigations on Antarctic fish eggs delt mainly with growth and development of eggs in the ovaries of different species (Marshall, 1953 ; Dearborn, 1965 ; Everson, 1970 ; Hureau, 1970). It was not before the late 1970's, that observations on the nesting behaviour and egg development of *Harpagifer bispinis* was published (Daniels, 1978, 1979). Moreno (1980) described, in detail, the egg development of *Pagothenia bernacchii* from egg masses found in shallow waters. White *et al.* (1982) and Camus and Duhamel (1985) have used artifical fertilization to investigate the development of *Notothenia neglecta* and *Notothenia rossii rossii* eggs, respectively.

During the third cruise to the Southern Weddell Sea with RV *Polarstern* (ANT III/3) in austral summer 1984/85, a sample of eggs of *Trematomus eulepidotus* was caught with a bottom trawl. The development of these eggs was successfully observed over a period of 5 months and new data were obtained on egg stages and size of larvae at hatching.

MATERIAL

The egg batch was found on February 1st, 1985 at 73°39.4'S, 20°59.8'W, station PS 06-287, in the Weddell Sea (Fig. 1). Water depth was about 200m. Bottom temperature was not measured at this station, but it can be estimated from surrounding stations to have been about -1.7°C. The total catch of 5 tons at this station mostly consisted of sponges. About 560 specimens of fish, mainly *Trematomus* species were caught. Detailed information about the station was published in the cruise report (Hempel, 1985).

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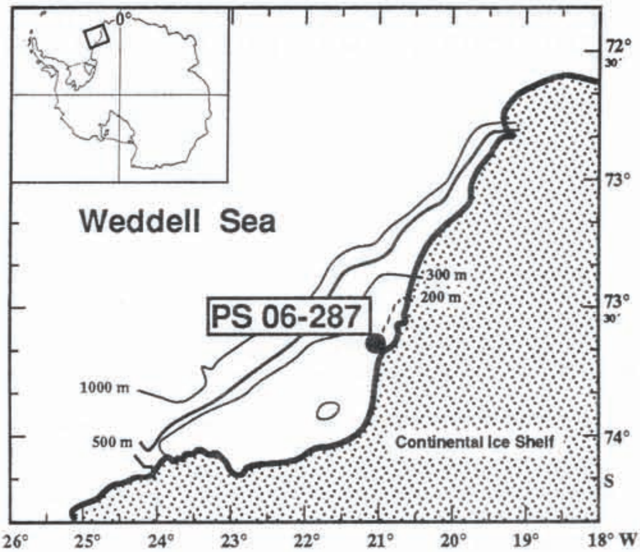

Fig. 1 : The Antarctic continent as an overview, and the investigation area during *Polarstern*-cruise ANT III/3 (Jan./Feb. 1985) in the eastern Weddell Sea. The sampling site was located near the ice edge (station PS 06-287).

The eggs (approximately 2000) were found among the sponges, many of them were damaged by the sponge needles. About half of the ova (984 eggs), which were free of sponge needles, was put into a small aquarium of 10 liters and incubated at a mean temperature of 0°C (range -1.2 to +1.0°C) until hatching. The water was aerated slightly and changed once a week. Species identification was based on spawning time as well as on dentition, pigmentation and number of myomeres in the embryos.

To study the different development stages, egg sub-samples were preserved on the first day (Feb.1st, 1985) and then at varying intervals until July 9th, 19 85. The egg stages were classified after APSTEIN (Hempel, 1979 ; Westernhagen, 1968).

Egg diameter and body proportions (after Hureau, 1982) of fresh and preserved material (4% buffered formalin seawater solution) were measured under a microscope to within 0.1 mm. An approximate timetable for the egg development was established.

RESULTS

Identification of eggs and larvae

Measurements of the egg diameters gave the following results :

fresh: $\bar{d}$ = 4.31 mm; s = 0.13 mm; range 4.17 - 4.56 mm; n = 12;

preserved: $\bar{d}$ = 4.26 mm; s = 0.10 mm; range 4.08 - 4.57 mm; n = 101

At the time the eggs were caught by the bottom trawl they were at the stage of gastrulation. This indicates that the species spawns during the summer. A high gonadosomatic index is usually a reliable indication of the spawning period in fish. Two species, *Trematomus eulepidotus* and *T. centronotus,* were found to have high gonadosomatic indices during summer (Ekau, 1988) and therefore probably spawn during this season.

The identification of larvae was based partly on pigmentation (Kellermann, pers. comm.) and on the myomere numbers (51 to 60, see Table II), which were compared with data from Andriashev (1959), Efremenko (1984) and Ekau (1988). This leads to the conclusion that the eggs were spawned by *Trematomus eulepidotus.*

Egg development

Table I summarizes the timetable of egg development. The eggs were caught on February 1st in stage I of the APSTEIN-table (Hempel, 1979 ; Westernhagen, 1968). The yolk had a deep yellow colour, the rest of the egg was transparent. The chorion was generally smooth with a wrinkly structured cap (Fig. 2a). The perivitelline space comprised about 6% of the diameter. No oil globules were observed. Stages II and III were found on March 9th (see Fig. 2b). The eyes were developed and in some cases pectoral fins were differentiated. The primordial marginal fin and gut was beginning to develop. The embryo surrounded the yolk to about 180°. Samples of April 9th showed the stages III and IV, on May 3rd stages III to V, mainly IV were found (Fig. 2c). The primordial marginal fin was fully developed, the eyes were large and black with well developed lenses. Villiform teeth and first pigmentation were visible and myomeres distinguishable. The embryo surrounded the yolk up to 360°. From the middle of May onwards almost all of the eggs were in stage V ; the eyes became silvery, the organ of balance, heart, brain and gut were well differentiated. The hatching glands on the top of the head were developed.

Hatching stage

The first hatching occurred on June 11th. From that date onwards until the 9th July, 13 larvae hatched at irregular intervals. The hatching rate was very low. The majority of embryos apparently surpassed the normal hatching point and were over-developed. They continued to grow around the yolk and died after a short time, covered by fungi.

The newly hatched larvae were almost transparent, only the yolk was yellow and there were peritoneal and occipital melanophores as well as melanophores along the base of the ventral marginal fin. A few dorsolateral melanophores also appeared on the tail.

The yolk amounted to 5.3 mm^3, which is about a third of the yolk volume in stage I (stage I eggs with a mean diameter of 4.3 mm had about 16.2 mm^3 yolk i.e. 38.9% of the egg volume).

Morphometric measurements and counts of the larvae are listed in Table II. Fig. 2d shows a drawing of the newly hatched larvae, no. L1. Hatching length was 18.6 mm SL (alive). The range of L2 through L6/6 from 11.8 to 16.2 mm (fixed) is biased due to shrinkage caused by the formalin fixation and mortality. Length of gut is 30.8 to 44.9% of standard length. The eyes are circular with a diameter of 6.4 to 9.6% SL. The snout is short and slightly flattened and comprises 3.1 to 6.0% of SL. Head depth is between 13.1 and 19.5% SL. The number of myomers varies between 51 and 60.

DISCUSSION

A large part of the experiments was carried out on the research vessel itself where the facilities to incubate the eggs were limited. It was therefore not possible to obtain data on temperature dependant incubation time or mortality of eggs and larvae. Nevertheless these are the first data on a high Antarctic species and they provide a good idea of the early life history of a *Trematomus* species.

T. eulepidotus is the second most frequent notothenioid species in the area of investigation (Ekau, 1988). It constitutes 11 % of the demersal fish biomass, while *Chionodraco myersi*, a channichthyid, forms 49 % (Ekau, unpubl. data). Because of its relatively high biomass it is an important food for Weddell Seals (Plötz, pers. comm.). The species is pelagic and is abundant along the eastern Weddell Sea shelf area down to a depth of about 500 m (Andriashev, 1987 ; Ekau, 1988).

From the general biological results on *T. eulepidotus*, found by Hubold and Ekau (1987), Ekau (1988) and Schwarzbach (1988) and the results of this study, it is possible to reconstruct

Table I : Timescale of egg development stages (after APSTEIN (Hempel, 1979 ; Westernhagen, 1968)) from *Trematomus eulepidotus*. The dates of subsampling are indicated by arrows. The day of catch was February, 1st, the day of first hatching was june, 11th.

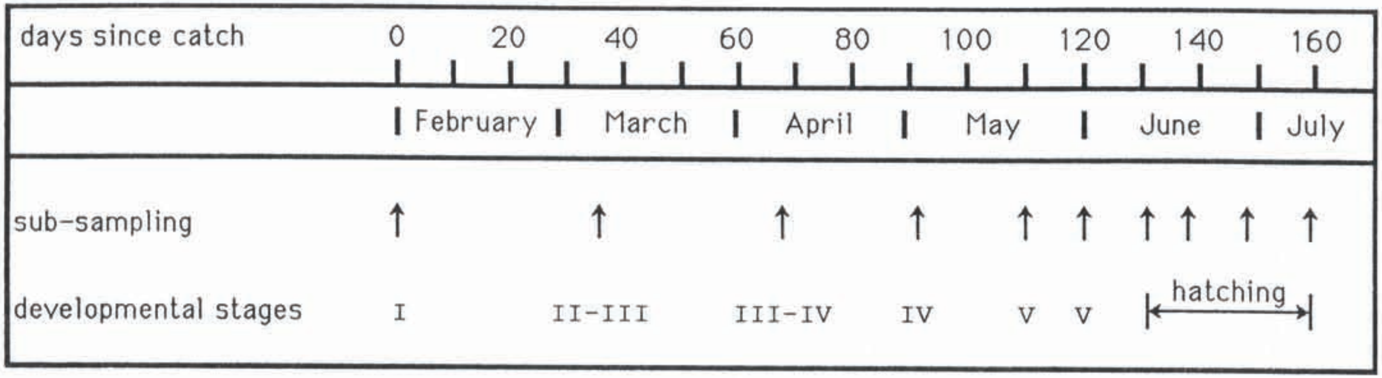

Table II : Morphometric and meristic measurements (after Hureau, 1982) of newly hatched larvae of *Trematomus eulepidotus* ; SL = standard length ; PAL = pre-anal length ; OD = orbital diameter ; POL = pre-orbital length ; HD = head depth. Myomeres were counted pre-anal, post-anal and total. Minimum and maximum values in each character are underlined. The larvae no. L6/1 to L6/6 were damaged and not used for morphometrics. L6/5 and L6/6 were removed from the eggs. L1-measurements were carried out on living specimens, others on preserved specimens.

Larvae no.	L1	L2	L3	L4/1	L4/2	L4/3	L6/1	L6/5	L6/6	L5	mean
Date of hatching	11.6.	18.6.	20.6.	28.6.	28.6.	28.6.	28.6.	9.7.	9.7.	11.7.	
Date of fixation	11.6.	18.7.	24.6.	28.6.	28.6.	28.6.	9.7.	9.7.	9.7.	11.7.	
SL [mm]	18.6	13.0	15.5	11.8	13.3	16.2	14.2	-	-	14.0	14.6
PAL [% SL]	30.8	44.9	40.8	36.6	34.4	37.2	44.1	-	-	44.4	39.2
OD [% SL]	6.4	8.7	6.9	9.6	7.6	7.4	6.7	-	-	8.5	7.7
POL [% SL]	3.8	3.1	3.4	6.0	4.4	5.5	-	-	-	5.5	4.5
HD [% SL]	13.1	18.1	13.2	19.5	15.5	14.2	-	-	-	-	5.6
Pre-anal myomeres	16	17	16	17	14	17	-	17	17	-	16.4
Post-anal myomeres	40	38	41	36	37	43	-	41	40	-	39.5
Total myomeres	56	55	57	53	51	60	-	58	57	-	55.9

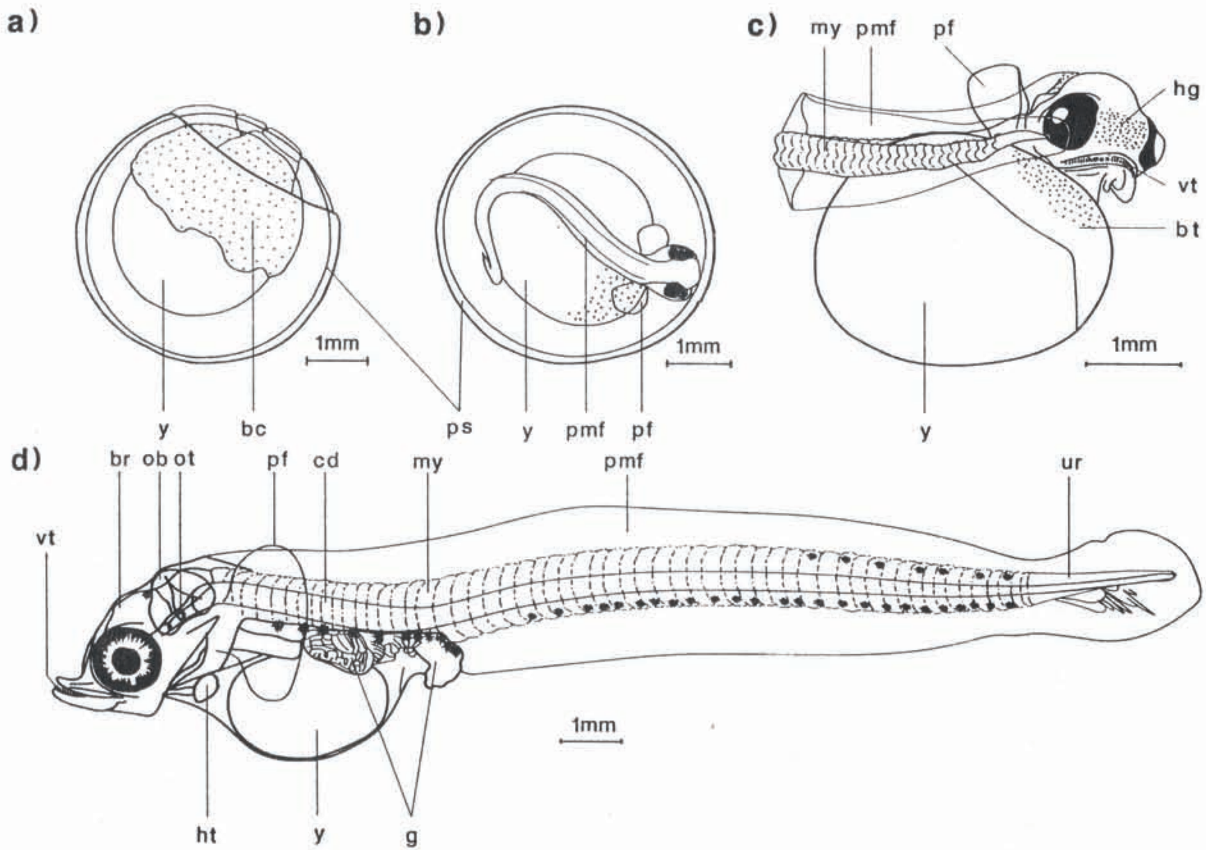

Fig. 2 : Development stages of eggs and newly hatched larvae from *Trematomus eulepidotus* : a) stage I (APSTEIN-table), blastula, egg diameter : 4.3 mm ; b) stage II-III, egg diameter : 4.2 mm ; c) stage IV, egg diameter : 4.3 mm, removed from the egg ; d) newly hatched larvae, total length : 18.6 mm. The following abbreviations were used : bc = blastula cells ; br = brain ; bt = body tissue ; cd = chorda dorsalis ; g = gut ; hg = hatching glands ; ht = heart ; my = myomeres ; ob = organ of balance ; ot = otoliths ; pf = pelvic fins ; pmf = primordial marginal fin ; ps = perivitelline space ; ur = urostyle ; vt = villiform teeth ; y = yolk.

the life cycle of this species. Spawning takes place during summer and may be restricted to shallow areas on the shelf, e.g. water depths less than 300 m. As this is the first finding of *T. eulepidotus* eggs, it is not clear whether the fish needs a certain substrate for spawning. The substrate at station PS 06-287 consisted mostly of sponges, of which some species attein large sizes, suggesting that they serve as spawning substratum. The absolute fecundity of *T. eulepidotus* is between 1400 and 12300 eggs per female, depending on the size of the fish (Ekau, 1989).

Development of the eggs takes at least 5 to 6 months, so that hatching occurs in winter. The duration of the egg development corresponds with the time observed by White *et al.* (1982) and Camus and Duhamel (1985), who worked on *Notothenia neglecta* and *Notothenia rossii rossii*, respectively. They found an incubation time from 103 (at +2 to 3 °C water temperature) to 150 days (-1.8 to -1 °C) for *N. neglecta* and from 66 to 100 days (2 to 4.5 °C) for *N. rossii*. Daniels (1978) found an incubation time of 125 days for *Harpagifer antarcticus*, but does not give temperatures. *T. eulepidotus* (this study) took more than 131 days at -1 to +1°C to hatch, as the eggs had already attained stage I when they were found. Incubation time, as shown by White *et al.* (1982), is correlated with ambient water temperature. On the shelf of the eastern Weddell Sea, where the eggs of *T. eulepidotus* were found, water temperature is constantly at about -1.7 to -1.8 °C. Thus the incubation time of Weddell Sea fish eggs in the natural environment may be even longer than the 5 to 6 months found in the aquarium at a mean temperature of 0 °C. The extremely low rate of hatching in this study may be caused by the lack of an unknown, but important hatching stimulus.

Larvae of *T. eulepidotus* are frequently found in the upper water layers. Hubold and Ekau (1987) and Hubold (1989) in Jan./Feb. 1985 found specimens between 30 and 50 mm in krill trawl and RMT (Rectangular Midwater Trawl) catches. Compared with a hatching length of about 18 mm, this indicates an increase in size of about 15 to 30 mm within the first 6 months of their life. The catches of *T. eulepidotus* larvae also indicate that the species, in contrast to most of the other notothenioids, has a relatively long pelagic period of several months, before the larvae (at lengths between 60 and 70 mm) descend to near the bottom. A subsequent depth dependant length distribution then follows with juveniles occurring mainly on the shelf plateau and bigger specimens at depths down to 500 m along the shelf edge (Ekau, 1988).

Besides this ontogenetic migration down to the shelf edge we suggest a spawning migration of the adults to shallow areas on the shelf plateau in early summer, which concludes the life cycle of *T. eulepidotus*.

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